

**Before the Hearings Panel
At Waimakariri District Council**

Under Schedule 1 of the Resource Management Act 1991

In the matter of the Proposed Waimakariri District Plan

Between **Various**

Submitters

And **Waimakariri District Council**

Respondent

**Statement of evidence of Christopher Paul Bacon on behalf of Waimakariri
District Council (Hydraulic Flood Modelling)**

Date: June 2023

INTRODUCTION:

- 1 My full name is Christopher Paul Bacon. I am employed as a Civil Engineer by the Waimakariri District Council in the role of Network Planning Team Leader.
- 2 I have prepared this statement of evidence on behalf of the Waimakariri District Council (**District Council**) in respect of technical related matters arising from the submissions and further submissions on the Proposed Waimakariri District Plan (**PDP**).
- 3 Specifically, this statement of evidence relates to the matters in the Natural Hazards Chapter related to Flood Modelling.
- 4 I am authorised to provide this evidence on behalf of the District Council.

QUALIFICATIONS AND EXPERIENCE

- 5 I hold the qualifications of Bachelor of Engineering (Hons), University of Canterbury.
- 6 I have 23 years' experience in Civil Engineering and have worked for the Waimakariri District Council for 25 years.
- 7 I am a Chartered Professional Engineer and an International Professional Engineer. I am a Chartered Member of Engineering New Zealand.

Code of conduct

- 8 Although this is a District Council hearing, I have read the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note 2023. I have complied with the Code of Conduct in preparing my evidence and will continue to comply with it while giving oral evidence before the Independent Hearing Panel. My qualifications as an expert are set out above. Except where I state I rely on the evidence of another

person, I confirm that the issues addressed in this statement of evidence are within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from my expressed opinions.

SUMMARY

- 9 My name is Christopher Paul Bacon.
- 10 I have been asked by the Council to provide Flood Modelling evidence in relation to the submissions and further submissions on the Natural Hazards Chapter.
- 11 My statement of evidence addresses issues related to the Flood Modelling used to inform the development of the provisions in the PDP and its application to the proposed Natural Hazards Chapter.
- 12 I support removing the Kaiapoi minimum fixed floor level overlay from the PDP in favour of adopting the Floor Level Certificate process to provide better consistency with other urban areas. However, I still support assessing Floor Level Certificates in these areas using a minimum fixed floor level approach due to the nature of flooding. With no overland flow paths these areas will effectively act as basins under a major flood event resulting in a widespread uniform flood level. The assessed minimum fixed floor levels for these areas are based on an assessed maximum 0.5% AEP uniform flood level.
- 13 I do not support applying a minimum fixed floor level across other parts of the district such as Southbrook because the sloping nature of the land and the presence of natural overland flowpaths means the predicted flood levels are not uniform and will vary across each site. For these sites it is necessary to undertake a site-specific assessment.
- 14 I support the provisions for allowing new critical infrastructure in the Coastal Hazards Overlay to ensure existing established communities can

continue to be serviced. I also support expanding the scope of permitted activities under these rules to allow overhead infrastructure to be constructed in the Coastal Hazards Overlay with appropriate allowances made for supporting structures under the site coverage rules. This includes assessing above ground linear infrastructure on a per structure basis.

- 15 I support the retention of the proposed urban flood overlays to ensure only those urban areas predicted to be at risk of flooding are subject to a floor level certificate process. I consider that for other urban properties protection by formal stormwater drainage systems should only be subject to minimum requirements under the Building Act.
- 16 I support extending the non-rural flood overlay to include all rural flat terrain in the district to reflect:
- a. the potential for flooding anywhere on flat terrain; and
 - b. the relative lower level of confidence in the rural flood modelling results compared to the urban results.
- 17 I support specifying the freeboard requirements within the PDP to reflect the relative risk of the different flood hazard categories used as follows:
Very Low and Low Hazard – 400 mm freeboard
Medium and High Hazard – 500 mm freeboard
- 18 I support the consideration of negative impacts to neighbouring properties when specifying new finished floor levels under the Matters of Discretion.

INVOLVEMENT WITH THE PROPOSED PLAN

- 19 I have been involved in developing the flood mapping used in the PDP since 2019 and have provided advice when requested on district plan provisions that seek to manage flood risk.

SCOPE OF EVIDENCE

- 20 My evidence only covers matters raised by submitters and in relation to the topic of flooding. For clarity I have presented the submissions grouped into sub-section type.

DEFINITIONS

- 21 In regards to submission [316.54] (ECAN), I agree that the current definition of High Coastal Flood Hazard is inconsistent with the definition under the Canterbury Regional Policy statement. Following discussions with ECAN I support deleting the current PDP definitions of 'High Coastal Flood Hazard' and 'High Flood Hazard' and replacing these by a single definition of 'High Hazard Area' as follows:

"High Hazard Area means:

a. land likely to be subject to coastal erosion; and

b. land where there is inundation by floodwater and where the water depth (metres) x velocity (metres per second) is greater than or equal to 1, or where depths are greater than 1 metre, in a 0.2% Annual Exceedance Probability flood event.

When determining a. and b. above, the cumulative effects of climate change over the next 100 years (based on latest national guidance) and all sources of flooding (including fluvial, pluvial, and coastal) must be accounted for.

- 22 In regards to submission [207.3] (Summerset), I disagree that the High Hazard Flood areas need to be shown on the planning maps. Because the high hazard areas are defined by flood modelling it is possible these will need to be updated due to changes in ground formation and future modelling outputs. Furthermore, when land development occurs this will often lead to changes in the flood hazard category especially when land is raised to mitigate the flood hazard. Due to the non-static nature of the flood hazard it is better to manage these layers outside of a district plan map. The proposed approach to use a flood hazard overlay

on the planning maps together with published flood hazard results outside of the maps provide a greater degree of flexibility and allows the Council to respond better when flood information changes. I disagree with the proposed amendment to the planning maps to show high hazard flood model layers on these maps.

ACTIVITY RULES

- 23 In regards to submission [193.52] (Martin Pinkham), I disagree that a minimum fixed floor level ('minimum FFL') approach should be adopted across the Rangiora and Woodend Medium Density Residential Zones. A minimum FFL approach is only appropriate for those areas subject to coastal inundation or ponding with no significant overland flowpaths. For the Waimakariri District this includes the urban areas of Kaiapoi, Pines Beach/Kairaki, Woodend Beach and Waikuku Beach. In other areas of the district the sloping nature of the land and the presence of overland flowpaths means it is not possible to define an area wide maximum flood level and instead site specific considerations are needed. I disagree with the proposed application of rule NH-R6(2) (Above ground critical infrastructure) as it relates to the Kaiapoi minimum fixed floor level overlay for the Rangiora and Woodend Medium Density Residential Areas.
- 24 In regards to submissions [195.61] (Transpower) and [195.63] I agree that rules should apply to each individual structure and that infrastructure assets in the coastal hazards overlay should be generally permitted. I agree with the proposed amendments to rules NH-R6 and NH-R17 (both rules related to 'Above ground critical infrastructure') as set out in the Natural Hazards s42A report.
- 25 In regards to submission [166.31] (NZDF), I agree that rule NH-R5 (Above ground infrastructure that is not critical infrastructure) should exclude infrastructure for Temporary Military Training Activities. I agree with the proposed amendment to rule NH-R5 as set out in the Natural Hazards s42A report.

- 26 In regards to submission [207.13] (Summerset), I acknowledge that rule NH-R1 ('Natural hazard sensitive activities') which permits new buildings in Urban Flood Assessment Overlay areas and rule NH-R3 ('Natural hazard sensitive addition to existing natural hazard sensitive activities') which does not permit additions in high hazard areas represents a small discrepancy. The purpose behind these rules is to ensure no additional structures are built in areas of high hazard outside of urban areas. Within the urban flood assessment overlay, flood hazard can be managed and controlled with Council infrastructure whereas outside of these areas it is not possible to manage the risk. I therefore recommend that NH-R3 is amended to add a reference to the Non-Urban Flood Assessment Overlay. I agree with the proposed amendment to Rule NH-R3(2)(d) as set out in the s42A report.
- 27 In regards to submission [249.175] (MainPower), I agree that new overhead electricity distribution lines and support structures should be a permitted activity under rule NH-R6 ('Above ground critical infrastructure'). I also agree that the clause 2(c)(i) should be amended to reflect the maximum size of typical cabinets and kiosks associated with this infrastructure. I agree with the proposed amendments to rule NH-R6 as set out in the submission and the s42A report.
- 28 In regards to submission [266.16] (199 Johns Road Ltd; Carolina Homes Ltd; Carolina Rental Homes Ltd; Allan Downs Ltd), I disagree that NH-R10 ('Construction of new community scale natural hazard mitigation works) should be amended in relation to earth engineered bunds. I consider that an earth engineered bund is not 'soft engineering' as required by NH-R10(1), but is defined as 'hard engineering natural hazard mitigation' under that PDP definition¹ As such an earth engineered bund is a Restricted Discretionary activity under NH-R10. I do not consider it appropriate to make such works a permitted activity

¹ Hard Engineering Natural Hazard Mitigation means the construction of, usually artificial, physical structures or resistant barriers, to avoid flood damage or slow down or prevent erosion or inundation of the coastline. Such structures include stop banks, seawalls, gabions, breakwaters, and groynes.

under NH-R10 due to the potential impacts and risks associated with these works.

- 29 In regards to submission [275.23] (Waka Kotahi), I disagree to some extent that the need to obtain a Flood Assessment Certificate for any type of critical infrastructure that increases the existing ground level by 250 mm is inefficient. Any works undertaken that directly affect an overland flowpath or that might cause an increase in flood level on a neighbouring property should go through the process to obtain a flood assessment certificate. While I agree that the figure of 250 mm is arbitrary it had been chosen as the 'trigger level'. The purpose of specifying 250 mm under NH-R6 ("Above ground critical infrastructure") was to provide a pragmatic figure large enough to capture any major works, with any minor works not being affected. However, it is also noted that an increase less than 250 mm over an overland flowpath could potentially cause a significant effect. Due to the arbitrary nature of the 250 mm trigger level, I recommend that rule NH-R6 is amended to remove the reference to 250 mm and a new rule drafted to focus simply on the adverse effects of Above Ground Critical Infrastructure.
- 30 In regards to submissions [316.77], [316.78] and [316.84] (ECan), I disagree that rules NH-R1(1), NH-R2(1) and NH-R15(1) relating to the proposed existing consent notice provision could enable inadequate standards of flood mitigation due to existing information becoming outdated. It is necessary to give consent holders some certainty surrounding their consent conditions in the short to medium term. Five (5) years is considered an appropriate amount of time to honour conditions imposed using the best information available at the time. It is noted that any resource consent condition imposed over the last five years will not have referenced a flood level less than the 200 year ARI event and in all cases a conservative freeboard of at least 400 mm will have been applied. The modelling and the associated results are only likely to be updated every 6 to 9 years following a new LIDAR survey. Furthermore, the modelling results from any future modelling exercise are unlikely to change significantly. Therefore the 5 year period seems

reasonable to hold consent conditions and give certainty to applicants. I disagree with the proposed amendments to Rules NH-R1(1), NH-R2(1) and NH-R15(1) to address information being updated during a consent notice term. I understand that the s42A report author has addressed the issue of expiry date for consent notices and concur with his recommended approach.

- 31 In regards to submission [316.77] (ECan), I acknowledge that the Kaiapoi Fixed Minimum Floor Level Overlay is inflexible should modelling results change. However, I support the minimum floor level approach in Kaiapoi and the coastal communities due to the ponded nature of flooding in these areas. I therefore recommend that the Kaiapoi Fixed Minimum Floor Level Overlay is removed from the plan and replaced instead by the Floor Level Certificate approach, providing consistency with other urban areas under the Urban Flood Assessment Overlay. It is also recommended that Council staff adopt the use of a 0.5% AEP Fixed Minimum Floor Level Overlay map when assessing Floor Level Certificates under the PDP for these affected areas and this map is published on the Council website to provide certainty to homebuilders in these areas.
- 32 In regards to submission [316.78] (ECan), I disagree that rule NH-R2(3)² would result in many applicants building to a higher level than required or conversely not achieving adequate mitigation against flooding. The 400 mm above natural ground level rule under NH-R2(3) used in the rural area where modelled flood levels are less than 100 mm is based on the principal that 100 mm of flooding could still occur due to unforeseen events and with the associated 300 mm freeboard this is considered an appropriate level of protection for rural properties with little or no associated formal stormwater infrastructure. This approach is generally conservative given the relatively flat nature of the Canterbury Plains and it means the numerous uncertainties associated

² Residential unit or a minor residential unit outside the Non-Urban Flood Assessment Overlay in the Rural zone

with forecasting flood levels in the rural area are still accounted for and the overall process is kept simple. In all cases there is an opportunity for any applicant to challenge the proposed finished floor levels provided by Council by undertaking their own flood hazard assessment. However, given that it is now proposed to extend the non-urban overlay into all areas of 'flat' rural land I agree that Rule NH-R2(3) can be deleted.

33 In regards to submissions [316.79] and [316.80] (ECan), I agree that any filling associated with below or above ground infrastructure within overland flowpaths should not be a permitted activity. The filling of overland flowpaths was not included in the Natural Hazards Chapter as it was already addressed in the Earthworks Chapter. However, given the high level of risk associated with filling within overland flowpaths, I agree that it should also be included in the Natural Hazard Chapter. I agree that provisions should be added to Rules NH-R4 and NH-R5 to address filling within overland flow paths as set out in the s42A report.

34 In regards to submission [316.86] (ECan), I disagree that rule NH-R17 should be deleted to prevent construction of new above ground infrastructure in the coastal flood assessment overlay. Above ground critical infrastructure should be allowed for in high hazard areas provided suitable mitigation has been provided. In some parts of the district where existing communities have been established in high hazard areas it is necessary to maintain critical infrastructure to those communities. I disagree with the proposed deletion of Rule NH-R17 to prevent construction of new above ground infrastructure in the coastal flood assessment overlay.

35 In regards to submissions [325.119] and [325.127] (Kainga Ora), I disagree that rule NH-R1 ('Natural hazard sensitive activities') and standard NH-S1 ('Flood Assessment Certificate') should be amended to delete the Urban and Non-Urban Flood Assessment Overlays. The purpose behind the flood assessment overlays is to provide a practical means of managing flood risk in areas known to be at risk of flooding.

In areas outside of flood overlays the risk is substantially lower and it is not considered necessary to undertake a detailed examination of every application in these areas. It would be my preference to see the associated flood maps including the minimum FFL overlay be maintained outside of the plan to provide flexibility to make updates as new information becomes available. However, that approach does not provide certainty for new applicants and I understand there are planning considerations associated with not having the plans within the district plan document. In the event that the modelling or underlying information is updated this will be done via a plan change. I disagree with the proposed amendment of Rule NH-R1 and Standard NH-S1 to remove the Urban and Non-Urban Flood Assessment Overlays.

- 36 In regards to the proposed changes to rule NH-R6(1) in the s42a report, I support including above ground roading infrastructure where it doesn't displace floodwaters in a 0.5% AEP event as a permitted activity from a practical engineering perspective. Most roads are generally constructed at ground level and are often used and designed to help convey overland flow (particularly in urban areas). The only occasions where a road should be protected from flooding is where it forms part of a strategic link, such as a state highway. However, where new road construction would raise the existing ground surface and potentially impact on surrounding land it would be appropriate for that infrastructure to obtain a flood assessment certificate. It would not be appropriate in my opinion to require a flood assessment certificate for all constructed (or reconstructed) roads in the district.

NATURAL HAZARDS STANDARDS

- 37 In regards to submission [408.12] and [408.99] (Bellgrove Rangiora Ltd), I agree that a lower freeboard of 400 mm is appropriate in areas of very low to low flood hazard. This approach is also generally consistent with the Council's current approach. A 500 mm freeboard is still appropriate in areas of medium to high hazard which reflects the overall higher level of risk associated with these areas. I disagree with the exact

wording in the proposed clause (f) from the submitter as the terminology should refer to 'hazard' rather than 'risk' and the areas of medium hazard should not be in any way limited to areas next to basins or overland flow channels, but rather apply to any mapped areas of medium hazard. Additionally, the 500 mm freeboard requirement should also apply to high hazard areas and the rules applied to both NH-S1 and NH-S2. I would therefore recommend that further clarification be added to both standard NH-S1 and NH-S2 with the following wording to provide clarity for setting freeboard levels.

- Low Hazard – 400 mm freeboard
- Medium to High Hazard – 500 mm freeboard

38 In regards to submission [186.15] (Tim Stephenson), I disagree with reducing the 500 mm freeboard requirement under NH-S2 for medium or high hazard coastal flood areas. I agree that raising land in areas of high flood hazard can have a number of unintended consequences, however this does not exist as an option in Pines Kairaki which is within an area of high coastal flood hazard. Other solutions such as raised piles would be considered in these areas. In my opinion, the 500 mm freeboard requirement to be a sensible pragmatic level of protection in flood prone areas. The 500 mm is to allow for the following:

- Wave Action from vehicles and wind
- Failure in stormwater and flood control infrastructure (such as jammed flapgates, blocked culverts, slumping stockbanks etc)
- Computation Model Errors
- Survey Errors
- Construction tolerances
- Future land movement due to seismic events
- Uncertainty in climate change effects (rainfall and sea level rise)

The 500 mm figure is also consistent with values used by other Territorial Authorities across New Zealand.

39 In regards to submission [226.9] (McAlpines), I agree that a 1% AEP (1 in 100 year) approach would provide a more practical outcome for certain brownfield type development including replacement of existing housing stock. This is consistent with the current approach Council has adopted under the Operative District Plan. However, such an approach does not give effect to the Regional Policy Statement (RPS) which requires a 0.5% (1 in 200 year) level of protection. The Council is required to give effect to the RPS under the Proposed District Plan. I therefore disagree that the proposed approach under NH-S1 for setting floor levels relative to the 0.5% AEP (1 in 200 year event) should be deleted in favour of a new method employing a 1% AEP (1 in 100 year) level of protection. I acknowledge that adopting the RPS 0.5% AEP requirement will make construction of habitable floor levels in many parts of Kaiapoi and the Coastal Flood Assessment Overlay much more challenging and expensive than is currently the case under the Operative Plan.

40 In regards to submission [316.88] (ECan), I agree that more clarity should be provided for setting freeboards. In reference to Paragraph 37 of this evidence I would therefore recommend that standard NH-S1 is modified with the following wording to provide clarity for setting freeboard levels.

- Low Hazard – 400 mm freeboard
- Medium to High Hazard – 500 mm freeboard

MATTERS OF DISCRETION

41 In regards to submission [195.65] (Transpower), I agree with the proposed amendments to the Matters of Discretion NH-MD3(1 to 9) to improve expression and remove duplication. However I am not qualified to provide advice regarding the proposed change to the reference to cultural effects, NH-MD3(10). This matter has been addressed in the S42A report..

42 In regards to submission [207.14] (Summerset), I agree with the proposed amendments to the Matters of Discretion NH-MD1 under matters 1 and 2 to improve the clarity and intent of the items. However, I disagree with deletion of matter 7. In existing urban areas subject to significant flood risk it is necessary to consider the negative impact of raising floor and/or ground levels on neighbouring properties and the existing streetscape where there are existing well established urban communities. I would recommend that NH-MD1(7) is reworded to state:

7. The extent to which there are any ~~positive~~ negative effects from ~~a reduction~~ an increase in floor levels in relation to neighbouring buildings or the streetscape.

43 In regards to submission [316.90] (ECan), I disagree with the deletion of Matters of Discretion NH-MD1(7) and recommend a rewording of this item as per paragraph 41.

44 In regards to submission [316.91] (ECan), I disagree with the proposed deletion of Matters of Discretion NH-MD4(6) and NH-MD4(7). In existing urban areas subject to coastal flood risk it is necessary to consider the negative impact of raising floor and/or ground levels on neighbouring properties, the existing streetscape and community facilities or other buildings that are being used to support local community functions in areas where there are existing well established urban communities. However, I don't agree that the financial viability of the development should be a consideration under NH-MD4(6) as it is not a consideration under NH-MD1(7). I would recommend that NH-MD4(6) is reworded to state:

6. Whether there are any ~~positive~~ negative effects from ~~a reduction~~ an increase in floor or land levels in relation to accessibility, the height of the existing building, neighbouring buildings or the streetscape ~~or the financial viability of the development.~~

GENERAL

- 45 In regards to submission [147.5] (Kaiapoi Tuahiwi Community Board), it is noted that the floor level provisions do extend to all new flood sensitive buildings including those in brownfield areas such as Southbrook.
- 46 In regards to submissions [147.5] (Kaiapoi Tuahiwi Community Board) and [226.8] (McAlpines), I disagree that the Southbrook area should be subject to fixed minimum finished floor level requirements similar to those in Kaiapoi. A minimum FFL approach is only appropriate for those areas subject to coastal inundation or ponding with no significant overland flowpaths. For the Waimakariri District this includes the urban areas of Kaiapoi, Pines Beach/Kairaki, Woodend Beach and Waikuku Beach. In other areas of the district (including Southbrook) the sloping nature of the land and the presence of overland flowpaths means it is not possible to define a basin and an associated area wide maximum flood level and instead site specific considerations are needed.
- 47 In regards to submission [260.3] (Andrea and William Thomson), it is noted that LIDAR is not directly used to set finished floor levels. Where the Flood Hazard Assessment Certificates refer to a reduced level this is always based on surveyed ground points using modelled flood depths. The modelled flood depths are based off a hydraulic model that has been fully peer reviewed and is based off LIDAR ground levels. However, because a flood depth is used (rather than a modelled level) any inaccuracies associated with the LIDAR data are largely mitigated. There is an opportunity within the process for applicants to undertake their own flood assessment including modelling if they disagree with the Council model results and associated flood hazard assessment.
- 48 In regards to submission [316.51] (ECan), I generally disagree that it is necessary to apply the Urban and Non-Urban Flood Assessment Overlays to the whole district to resolve any possible gaps or limitations. The purpose behind the flood assessment overlay is to

restrict detailed flood assessments to only those areas that are at significant risk. This is a risk based approach that reduces the time and expense to both applicants and the Council investigating land that has little to no flood risk whilst devoting more attention to land that is clearly at risk of flooding. I also consider the 400 mm rule used in the rural area which is based on the principal that 100 mm of flooding could still occur due to unforeseen events together with the associated 300 mm freeboard is an appropriate level of protection for rural properties with little or no associated formal stormwater infrastructure. This approach is generally conservative given the relatively flat nature of the Canterbury Plains and it means the numerous uncertainties associated with forecasting flood levels in the rural area are still largely accounted for and the overall process is kept simple. However, I also acknowledge that the flood modelling results that define the proposed overlays will by their nature have some localised errors due to errors in the LIDAR data that could be better identified and managed through a flood assessment certificate process. The likelihood of modelling errors is generally higher in the rural zone in areas of flat topography where the model resolution is lower and there is less certainty associated with ground levels due to land use activities. The likelihood of modelling errors is much lower in urban areas where the modelling resolution is much higher and the stormwater systems are more formalised. I therefore disagree that changes should be made to the urban flood overlay in areas where detailed urban flood modelling has been undertaken but I agree that in other parts of the district with a 'flat' topography the flood overlays could be expanded further to cover all affected land. It is noted that by expanding the overlays to cover all land with a flat topography (outside of the urban modelled flood areas) will result in nearly all rural and rural residential buildings becoming subject to a floor level certificate process.

49 In regards to submission [316.52] (ECan), I agree that there are benefits associated with the flood maps including the Kaiapoi minimum FFL overlay being maintained outside of the plan to provide flexibility to

make updates as new information becomes available. However, that approach may provide less certainty for new applicants and there are planning considerations associated with not having the plans within the district plan document. In the event that the modelling or other underlying information is updated the flood information including any minimum finished floor level maps will be updated via a plan change. I agree that the datum used should be clearly stated on the Kaiapoi minimum FFL maps and in reference to Paragraph 31 of this evidence I have recommended that the Kaiapoi minimum FFL map is taken out of the PDP in favour of a Floor Level Certificate approach.

50 In regards to submission [316.64] (ECan), I agree that reference to 'significantly increased' flood displacement effects within NH-P3(2) can be reworded to instead reference 'no more than minor' effects. I would recommend that NH-P3(2) is reworded to state:

2. ~~the any increase in risk from flooding to surrounding properties is not significantly increased~~ is no more than minor

Date: 20/06/2023



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